

Claims

1. An isolated DNA molecule which comprises a polynucleotide encoding the polypeptide
5 of SEQ ID NO: 2 and functional derivatives thereof.

2. The isolated DNA molecule of claim 1 which comprises a polynucleotide encoding a
DTB synthetase, which polynucleotide is selected from the group consisting of:

10 a) SEQ ID NO: 1;

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a
DTB synthetase having the same amino acid sequence as that encoded by the
polynucleotide a); and

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c) a polynucleotide which hybridizes to the complement of the polynucleotide from a)
or b) under stringent hybridizing conditions.

3. The isolated DNA molecule of claim 2 which comprises a polynucleotide encoding a
20 DTB synthetase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 1; and

25 b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a
DTB synthetase having the same amino acid sequence as that encoded by the
polynucleotide a).

4. The isolated DNA molecule of claim 3 which comprises SEQ ID NO: 1.

30 5. An isolated DNA molecule which comprises a polynucleotide which encodes the
polypeptide of SEQ ID NO: 4 and functional derivatives thereof.

6. The isolated DNA molecule of claim 5 which comprises a polynucleotide encoding a DAPA aminotransferase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 3;

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a DAPA aminotransferase having the same amino acid sequence as that encoded by the polynucleotide a); and

c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

7. The isolated DNA molecule of claim 6 which comprises a polynucleotide encoding a DAPA aminotransferase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 3; and

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a DAPA aminotransferase having the same amino acid sequence as that encoded by the polynucleotide a).

8. The isolated DNA molecule of claim 7 which comprises SEQ ID NO: 3.

9. An isolated DNA molecule which comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 6 and functional derivatives thereof.

10. The isolated DNA molecule of claim 9 which comprises a polynucleotide encoding a KAPA synthetase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 5;

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a); and

- c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

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11. The isolated DNA molecule of claim 10 which comprises a polynucleotide encoding a
5 KAPA synthetase, which polynucleotide is selected from the group consisting of:

- a) SEQ ID NO: 5;
- b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a
10 KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a).

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12. The isolated DNA molecule of claim 11 which comprises SEQ ID NO: 5.

15 13. An isolated DNA molecule which comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 8 and functional derivatives thereof.

14. The isolated DNA molecule of claim 13 which comprises a polynucleotide encoding a
20 biotin synthase, which polynucleotide is selected from the group consisting of:

- a) SEQ ID NO: 7;
- b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a
25 biotin synthase having the same amino acid sequence as that encoded by the polynucleotide a); and
- c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

30 15. The isolated DNA molecule of claim 13 which comprises a polynucleotide encoding a biotin synthase, which polynucleotide is selected from the group consisting of:

- a) SEQ ID NO: 7;

- b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a biotin synthase having the same amino acid sequence as that encoded by the polynucleotide a).

5 16. The isolated DNA molecule of claim 15 which comprises SEQ ID NO: 7.

17. An isolated DNA molecule which comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 12 and functional derivatives thereof.

10 18. The isolated DNA molecule of claim 17 which comprises a polynucleotide encoding a KAPA synthetase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 11;

15 b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a); and

20 c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

19. The isolated DNA molecule of claim 18 which comprises a polynucleotide encoding a KAPA synthetase, which polynucleotide is selected from the group consisting of:

25 a) SEQ ID NO: 11;

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a).

30 20. The isolated DNA molecule of claim 11 which comprises SEQ ID NO: 11.

21. An isolated DNA molecule which comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 10.

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22. An isolated DNA molecule which comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 14.

5 23. An isolated DNA molecule which comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 16.

24. An expression vector which comprises a polynucleotide encoding the polypeptide of SEQ ID NO: 2 and functional derivatives thereof.

10 25. The expression vector of claim 24 which comprises a polynucleotide encoding a DTB synthetase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 1;

15 b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a DTB synthetase having the same amino acid sequence as that encoded by the polynucleotide a); and

20 c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

26. The expression vector of claim 25 which comprises a polynucleotide encoding a DTB synthetase, which polynucleotide is selected from the group consisting of:

25 a) SEQ ID NO: 1; and

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a DTB synthetase having the same amino acid sequence as that encoded by the polynucleotide a).

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27. The expression vector of claim 26 which comprises SEQ ID NO: 1.

28. An expression vector which comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 4 and functional derivatives thereof.

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29. The expression vector of claim 28 which comprises a polynucleotide encoding a DAPA aminotransferase, which polynucleotide is selected from the group consisting of:

5 a) SEQ ID NO: 3;

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a DAPA aminotransferase having the same amino acid sequence as that encoded by the polynucleotide a); and

10 c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

30. The expression vector of claim 29 which comprises a polynucleotide encoding a DAPA aminotransferase, which polynucleotide is selected from the group consisting of:

15 a) SEQ ID NO: 3; and

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a DAPA aminotransferase having the same amino acid sequence as that encoded by the polynucleotide a).

20 31. The expression vector of claim 30 which comprises SEQ ID NO: 3.

32. An expression vector which comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 6 and functional derivatives thereof.

33. The expression vector of claim 32 which comprises a polynucleotide encoding a KAPA synthetase, which polynucleotide is selected from the group consisting of:

30 a) SEQ ID NO: 5;

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a); and

- c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

✓ 34. The expression vector of claim 33 which comprises a polynucleotide encoding a
5 KAPA synthetase, which polynucleotide is selected from the group consisting of:

- a) SEQ ID NO: 5;
- 10 b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a).

35. The expression vector of claim 34 which comprises SEQ ID NO: 5.

15 36. An expression vector which comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 8 and functional derivatives thereof.

20 37. The expression vector of claim 36 which comprises a polynucleotide encoding a biotin synthase, which polynucleotide is selected from the group consisting of:

- a) SEQ ID NO: 7;
- 25 b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a biotin synthase having the same amino acid sequence as that encoded by the polynucleotide a); and
- c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

30 38. The expression vector of claim 37 which comprises a polynucleotide encoding a biotin synthase, which polynucleotide is selected from the group consisting of:

- a) SEQ ID NO: 7;

- b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a biotin synthase having the same amino acid sequence as that encoded by the polynucleotide a).

5 39. The expression vector of claim 38 which comprises SEQ ID NO: 7.

40. An expression vector which comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 12 and functional derivatives thereof.

10 41. The expression vector of claim 40 which comprises a polynucleotide encoding a KAPA synthetase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 11;

15 b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a); and

20 c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

42. The expression vector of claim 41 which comprises a polynucleotide encoding a KAPA synthetase, which polynucleotide is selected from the group consisting of:

25 a) SEQ ID NO: 11;

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a).

30 43. The expression vector of claim 11 which comprises SEQ ID NO: 11.

44. An expression vector which comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 10.

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45. An expression vector which comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 14.

5 46. An expression vector which comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 16.

10 47. A biotin-expressing cell transformed by an expression vector, which expression vector comprises a polynucleotide encoding the polypeptide of SEQ ID NO: 2 and functional derivatives thereof.

48. The cell of claim 47 in which the expression vector comprises a polynucleotide encoding a DTB synthetase, which polynucleotide is selected from the group consisting of:

- 15 a) SEQ ID NO: 1;
- b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a DTB synthetase having the same amino acid sequence as that encoded by the polynucleotide a); and
- 20 c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

25 49. The cell of claim 48 in which the expression vector comprises a polynucleotide encoding a DTB synthetase, which polynucleotide is selected from the group consisting of:

- a) SEQ ID NO: 1; and
- 30 b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a DTB synthetase having the same amino acid sequence as that encoded by the polynucleotide a).

50. The cell of claim 49 in which the expression vector comprises SEQ ID NO: 1.

51. A biotin-expressing cell transformed with an expression vector, which expression vector comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 4 and functional derivatives thereof.

5 52. The cell of claim 51 in which the expression vector comprises a polynucleotide encoding a DAPA aminotransferase, which polynucleotide is selected from the group consisting of:

10 a) SEQ ID NO: 3;

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a DAPA aminotransferase having the same amino acid sequence as that encoded by the polynucleotide a); and

15 c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

20 53. The cell of claim 52 in which the expression vector comprises a polynucleotide encoding a DAPA aminotransferase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 3; and

25 b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a DAPA aminotransferase having the same amino acid sequence as that encoded by the polynucleotide a).

54. The cell of claim 53 in which the expression vector comprises SEQ ID NO: 3.

30 55. A biotin-expressing cell transformed with an expression vector, which expression vector comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 6 and functional derivatives thereof.

35 56. The cell of claim 55 in which the expression vector comprises a polynucleotide encoding a KAPA synthetase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 5;

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b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a); and

c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

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✓ 57. The cell of claim 56 in which the expression vector comprises a polynucleotide encoding a KAPA synthetase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 5;

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b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a).

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✓ 58. The cell of claim 57 in which the expression vector comprises SEQ ID NO: 5.

59. A biotin-expressing cell transformed with an expression vector, which expression vector comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 8 and functional derivatives thereof.

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60. The cell of claim 59 in which the expression vector comprises a polynucleotide encoding a biotin synthase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 7;

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b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a biotin synthase having the same amino acid sequence as that encoded by the polynucleotide a); and

- c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

61. The cell of claim 60 in which the expression vector comprises a polynucleotide encoding a biotin synthase, which polynucleotide is selected from the group consisting of:

- a) SEQ ID NO: 7;
- b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a biotin synthase having the same amino acid sequence as that encoded by the polynucleotide a).

62. The cell of claim 61 in which the expression vector comprises SEQ ID NO: 7.

63. A biotin-expressing cell transformed with an expression vector, which expression vector comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 12 and functional derivatives thereof.

64. The cell of claim 63 in which the expression vector comprises a polynucleotide encoding a KAPA synthetase, which polynucleotide is selected from the group consisting of:

- a) SEQ ID NO: 11;
- b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a); and
- c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

65. The cell of claim 64 in which the expression vector comprises a polynucleotide encoding a KAPA synthetase, which polynucleotide is selected from the group consisting of:

- a) SEQ ID NO: 11;

- b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a).

5 66. The cell of claim 65 in which the expression vector comprises SEQ ID NO: 11.

67. A biotin-expressing cell transformed with an expression vector, which expression vector comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 10.

10 68. A biotin-expressing cell transformed with an expression vector, which expression vector comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 14.

69. A biotin-expressing cell transformed with an expression vector, which expression vector comprises a polynucleotide which encodes the polypeptide of SEQ ID NO: 16.

15 70. A process for the production of biotin which process comprises culturing a biotin-expressing cell transformed by an expression vector, which expression vector comprises a polynucleotide encoding the polypeptide of SEQ ID NO: 2 and functional derivatives thereof, in a culture medium whereby the cell expresses biotin into the culture medium, and isolating the
20 expressed biotin from the culture medium.

71. The process of claim 70 in which the expression vector comprises a polynucleotide encoding a DTB synthetase, which polynucleotide is selected from the group consisting of:

25 a) SEQ ID NO: 1;

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a DTB synthetase having the same amino acid sequence as that encoded by the polynucleotide a); and

30 c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

72. The process of claim 71 in which the expression vector comprises a polynucleotide encoding a DTB synthetase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 1; and

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a DTB synthetase having the same amino acid sequence as that encoded by the polynucleotide a).

73. The process of claim 72 in which the expression vector comprises SEQ ID NO: 1.

74. A process for the production of biotin which process comprises culturing a biotin-expressing cell transformed by an expression vector, which expression vector comprises a polynucleotide encoding the polypeptide of SEQ ID NO: 4 and functional derivatives thereof, in a culture medium whereby the cell expresses biotin into the culture medium, and isolating the expressed biotin from the culture medium.

75. The process of claim 74 in which the expression vector comprises a polynucleotide encoding a DAPA aminotransferase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 3;

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a DAPA aminotransferase having the same amino acid sequence as that encoded by the polynucleotide a); and

c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

76. The process of claim 75 in which the expression vector comprises a polynucleotide encoding a DAPA aminotransferase, which polynucleotide is selected from the group consisting of:

- 5 a) SEQ ID NO: 3; and
- b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a DAPA aminotransferase having the same amino acid sequence as that encoded by the polynucleotide a).

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77. The process of claim 76 in which the expression vector comprises SEQ ID NO: 3.

78. A process for the production of biotin which process comprises culturing a biotin-expressing cell transformed by an expression vector, which expression vector comprises a polynucleotide encoding the polypeptide of SEQ ID NO: 6 and functional derivatives thereof, in a culture medium whereby the cell expresses biotin into the culture medium, and isolating the expressed biotin from the culture medium.
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79. The process of claim 78 in which the expression vector comprises a polynucleotide encoding a KAPA synthetase, which polynucleotide is selected from the group consisting of:

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- a) SEQ ID NO: 5;
- b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a); and
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- c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.
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80. The process of claim 79 in which the expression vector comprises a polynucleotide encoding a KAPA synthetase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 5;

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a).

81. The process of claim 80 in which the expression vector comprises SEQ ID NO: 5.

82. A process for the production of biotin which process comprises culturing a biotin-expressing cell transformed by an expression vector, which expression vector comprises a polynucleotide encoding the polypeptide of SEQ ID NO: 8 and functional derivatives thereof, in a culture medium whereby the cell expresses biotin into the culture medium, and isolating the expressed biotin from the culture medium.

83. The process of claim 82 in which the expression vector comprises a polynucleotide encoding a biotin synthase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 7;

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a biotin synthase having the same amino acid sequence as that encoded by the polynucleotide a); and

c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

84. The process of claim 83 in which the expression vector comprises a polynucleotide encoding a biotin synthase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 7;

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a biotin synthase having the same amino acid sequence as that encoded by the polynucleotide a).

85. The process of claim 84 in which the expression vector comprises SEQ ID NO: 7.

86. A process for the production of biotin which process comprises culturing a biotin-expressing cell transformed by an expression vector, which expression vector comprises a polynucleotide encoding the polypeptide of SEQ ID NO: 12 and functional derivatives thereof, in a culture medium whereby the cell expresses biotin into the culture medium, and isolating the expressed biotin from the culture medium.

87. The process of claim 86 in which the expression vector comprises a polynucleotide encoding a KAPA synthetase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 11;

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a); and

c) a polynucleotide which hybridizes to the complement of the polynucleotide from a) or b) under stringent hybridizing conditions.

88. The process of claim 87 in which the expression vector comprises a polynucleotide encoding a KAPA synthetase, which polynucleotide is selected from the group consisting of:

a) SEQ ID NO: 11;

b) a polynucleotide which, because of the degeneracy of the genetic code, encodes a KAPA synthetase having the same amino acid sequence as that encoded by the polynucleotide a).

89. The process of claim 88 in which the expression vector comprises SEQ ID NO: 11.

90. A process for the production of biotin which process comprises culturing a biotin-expressing cell transformed by an expression vector, which expression vector comprises a polynucleotide encoding the polypeptide of SEQ ID NO: 10, in a culture medium whereby the cell expresses biotin into the culture medium, and isolating the expressed biotin from the culture medium.

91. A process for the production of biotin which process comprises culturing a biotin-expressing cell transformed by an expression vector, which expression vector comprises a polynucleotide encoding the polypeptide of SEQ ID NO: 14, in a culture medium whereby the cell expresses biotin into the culture medium, and isolating the expressed biotin from the culture medium.

92. A process for the production of biotin which process comprises culturing a biotin-expressing cell transformed by an expression vector, which expression vector comprises a polynucleotide encoding the polypeptide of SEQ ID NO: 16, in a culture medium whereby the cell expresses biotin into the culture medium, and isolating the expressed biotin from the culture medium.
